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OBSERVED SOLAR PRESSURE PERTURBATIONS OF ECHO I

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ABSTRACT

During the period 13 August to 22 August, day-to-day determinations of the average orbital elements of the 100-ft Echo I balloon, based on observations taken at the Jet Propulsion Laboratory's Goldstone tracking station, indicated a decrease in perigee height of 3.0 km per day and an increase in the eccentricity of 0.00038 per day.

OBSERVED SOLAR PRESSURE PERTURBATIONS OF ECHO I[1]

The NASA satellite Echo I was placed in a 1000-mile nearly circular orbit on 12 August 1000 hours U. T. with an inclination of 47. 2 degrees. This is a 100-ft aluminumized-plastic balloon which was launched for the purpose of inter- and transcontinental communications experiments.

The Satellite was tracked for about three passes per day for a 10-day period with the Jet Propulsion Laboratory's 85-ft parabolic antenna at Goldstone, California. Angle observations were made with a precision of about 0. 05 degree, and doppler velocity with a precision of better than 1 meter per second for most of the passes. Each pass consisted of about 50 observations over a 10 minute interval.

On 13 August and 14 August data were taken for five passes (a one-day arc) over Goldstone. Using the JPL orbit determination program (Ref. 1) the cartesian position and velocity were obtained for the epoch 13 August 0455 U. T.

The cartesian elements for the 13 August epoch were then integrated forward for a 10-day arc, using an Encke method which included perturbations due to the Earth's oblateness, Sun and Moon gravitational effects, and a solar pressure term. Due to the height of the orbit, aerodynamic drag was neglected. A solar radiation pressure of 4.5×10^{-5} dynes/cm^2 was used, giving an acceleration of 5×10^{-5} meters/sec^2 assuming specular reflection and a mass of 137 lb. During the

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integration over the 10-day arc the classical osculating elements were printed out at 45-minute intervals. These elements were then averaged over periods of one day to produce the solid curves for eccentricity, e, and perigee, q, shown in Figure 1. These curves then represent the average values of the elements as predicted by numerical integration from the 13 August epoch.

The slope of the curves was determined graphically to be 0.00038 per day for the eccentricity and -3.0 km per day for the perigee.

The data points in Figure 1 represent days on which the Goldstone station obtained data for two successive passes, that is, a 2.5-hour arc. For each of these, the orbit determination program was again used to obtain the cartesian elements at an epoch near the beginning of the arc. These elements were then integrated foreward for one period of the satellite (about 2 hours) and the classical osculating elements were printed at 6-minute intervals. These elements were averaged over the 2-hour period to obtain the points shown in Figure 1.

The agreement of the data points determined day-to-day and the 10-day prediction including an acceleration due to the solar radiation pressure appears reasonable. The day to day determination of the semimajor axis, a, is also shown in Figure 1. The fact that a remains constant within 1 km over the period of interest indicates that the assumption of negligible drag was valid.

The observed decrease in perigee of the Echo I satellite is substantially in agreement with that predicted by Parkinson, Shapiro, and Jones in Ref. 2.

REFERENCES

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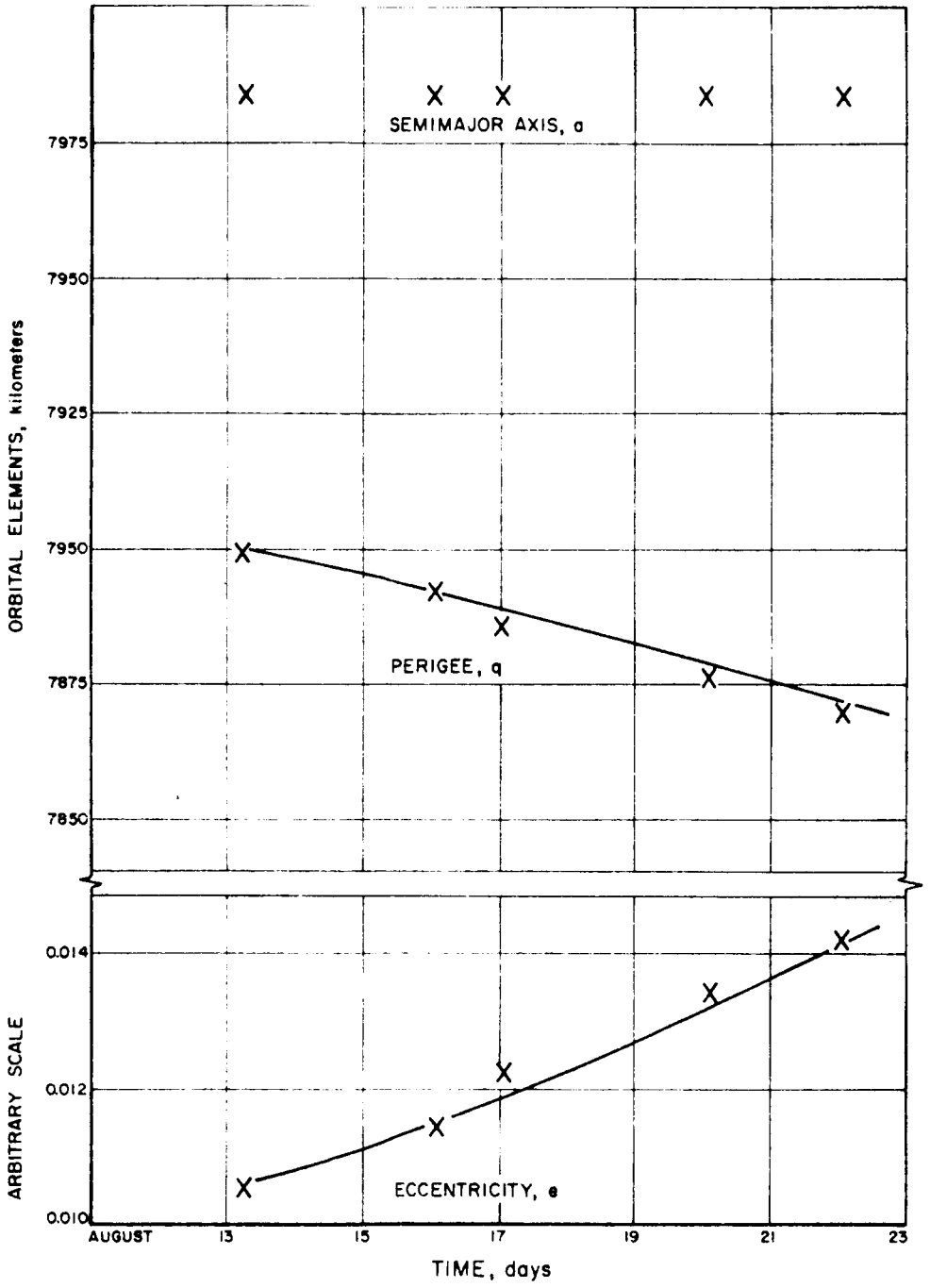

Fig. 1. Effect of solar radiation pressure on orbital parameters of Echo I